PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-202531

(43)Date of publication of application : 19.07.2002

(51)Int.Cl. G02F 1/167

(21)Application number : 2000-402885

(22)Date of filing : 28.12.2000

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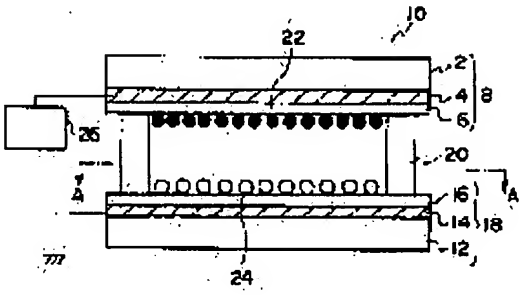
(54) IMAGE DISPLAY MEDIUM AND IMAGE FORMING APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an image display medium which changes only slightly its image density and its uniformity of densities even if it is rewritten repeatedly for a long period of time, and can provide image display with a stable density and contrast, and to provide an image forming apparatus.

SOLUTION: The image display medium comprises a pair of substrates 8 and 18 which are oppositely disposed, and a particle group consisting of at least two or more kinds of particles 22 and 24 enclosed in the space between the pair of substrates 8 and 18. At least one of the two or more kinds of particles 22 and 24 has a property that it can positively be charged, and at least the other kind has a property that it can negatively be charged, and the particles which can positively/negatively be charged have a different color each other. The value of coefficient of variation in the particle size distribution of both particles 22 and 24 which can positively/negatively be charged is 15% or less. The image forming apparatus uses the above medium.



LEGAL STATUS

[Date of request for examination]	07.09.2004
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	
[Date of registration]	
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the image display medium in which repeat rewriting which used the particle is possible, and image formation equipment.
[0002]
[Description of the Prior Art] It is TwistingBall as an image display medium in which repeat rewriting is more possible than before. Display techniques, such as liquid crystal which has Display (2 color coating division particle rotation display), electrophoresis, magnetic migration, a Sir MARURI writer bull medium, and memory nature, are proposed. Although said display technique was excellent in the memory nature of an image, it could not consider the screen as a white display like paper, but had the problem that concentration contrast was low.
[0003] As a display technique using the toner which solves the above problems on the other hand Enclose a conductive coloring toner and a white particle between the electrode substrates which counter, and a charge is poured in to a conductive coloring toner through the charge transportation layer prepared in the inside front face of the electrode substrate by the side of non-display. The conductive coloring toner by which charge impregnation was carried out moves to the electrode substrate by the side of the display which counters the electrode substrate by the side of non-display, and is located by the electric field given between two-electrodes substrates, and adheres to the electrode substrate inside by the side of a display. The display technique which carries out image display by the contrast of a conductive coloring toner and a white particle is proposed (Japan Hardcopy'99 collected works, p.249-252). All image display media are constituted in solid form, and this display technique is excellent in the point which can change a black (color) display to white 100% theoretically. However, it is [0004] in which the conductive coloring toner isolated from the conductive coloring toner which does not touch the charge transportation layer prepared in the electrode inside front face of a non-display substrate with the above-mentioned technique, and other conductive coloring toners exists, and the problem that where of concentration contrast will become low is since a charge is not poured in, and these conductive coloring toners do not move by electric field but exist between two-electrodes substrates at random. this invention persons have proposed the image display medium containing the particle group which is two or more kinds in which a color and an electrification property differ from the substrate of a pair while the impressed electric field enclose between said substrates between said substrates movable as an image display medium which is excellent in the concentration contrast which used the particle (application for patent No. 165138 [2000 to]). According to this proposal, a high whiteness degree and concentration contrast are acquired. Although the configuration of the particle in this proposal was excellent in white concentration, black concentration, and concentration contrast in the first stage, when it rewrote repeatedly over a long period of time, image concentration fell, concentration contrast might fall, and the homogeneity of an image might fall and it might produce image unevenness.
[0005]
[Problem(s) to be Solved by the Invention] Therefore, even if this invention solves the above-mentioned

trouble and it rewrites repeatedly over a long period of time, it aims at offering the image display medium which can offer the image display of the concentration contrast which was small, and was stabilized, and image formation equipment. [of the concentration homogeneous change with a small and change of image concentration]

[0006]

[Means for Solving the Problem] It became clear wholeheartedly that destabilization of the amount of electrifications by the frictional electrification between particles in the above-mentioned trouble and broadcloth-ization of charge distribution (electrification distribution) were the causes as a result of research. And in order to stabilize the amount of electrifications by the frictional electrification between particles, it came to hit on an idea of it being effective to make suitable the value of the coefficient of variation in the particle size distribution of the particle to be used to a header and this invention.

[0007] Namely, the particle group which this invention becomes from at least two or more kinds of particles enclosed with the opening between the substrate of the pair by which opposite arrangement was carried out, and the substrate of this pair, since -- this -- at least one of kinds [them] just [two or more kinds of particles] The particle which has the property in which other at least one kind may be charged in negative, and may be charged to said positive/negative is the image display medium which is a mutually different color, and the value of the coefficient of variation in the particle size distribution of the particle of the both sides which may be charged to said positive/negative is the image display medium characterized by being 15% or less.

[0008] In this invention, it is important that it is the color from which the particle which may be charged to said positive/negative differs mutually, and the particle size distribution are sharp distribution mutually. Concentration contrast is acquired between the image part which consists of a particle group which may be charged in forward [said] because colors differ, the image part which consists of a particle group which may be charged in negative [said], and **. Moreover, since the speed of the responsibility between the particles between the substrates of this pair at the time of electrical-potential-difference impression can be improved and the impingement efficiency of particles improves by making into Sharp the particle size distribution of the particle of the both sides which may be charged to said positive/negative, frictional electrification is stabilized and it becomes possible to narrow electrification distribution.

[0009] In the image display medium of this invention, it is desirable for one side of the particle which may be charged to said positive/negative to be white. By making one of particles into white at least, the tinting strength of the particle of another side and concentration contrast can be improved. Moreover, as for the particle of the white concerned, it is desirable for this color material to be titanium oxide including color material. By using titanium oxide as a color material, in the range of the wavelength of the light, obliterating power can be made high and concentration contrast can be improved further.

[0010] It is desirable that it is the particle obtained when the component from which the particle which may be charged in forward [said], and/or the particle which may be charged in negative [said] constitute this particle in the image display medium of this invention made it move to the aqueous phase through the film which has pore and corned the oil phase dissolved and/or distributed.

[0011] It is made to move to the aqueous phase through the film which has pore, and the particle manufactured by the above-mentioned approach is made into an oil droplet, since it is made to corn, the particle size of a particle is governed by the path of the pore of said film, consequently only controls the pore of said film, and can make the particle size distribution of the particle obtained sharp. Therefore, the particle of the particle size distribution specified to this invention can be manufactured easily, and the effectiveness of this invention is easily reached at a high dimension.

[0012] On the other hand, the image formation equipment of this invention is image formation equipment which forms an image in the image display medium of above-mentioned this invention, and is characterized by having an electric-field generating means to generate the electric field according to an image, between the substrates of said pair.

[0013]

[Embodiment of the Invention] Hereafter, this invention is explained to a detail.

[the mechanism of action of this invention] -- the mechanism of action of this invention is explained first. At least two or more kinds of particles enclosed with the opening between the substrates of the pair by which opposite arrangement was carried out are mixed and stirred in the container for stirring at a rate of the specified quantity. Frictional electrification is made between each particle and between a particle and a container wall in process of this mechanical stirring mixing, and it is thought that each particle is charged. Then, the mixed particle is enclosed with the opening between the substrates of said pair so that it may become a predetermined rate of volume filling. The enclosed particle goes back and forth between substrates according to electric field by the polar change of the direct current voltage impressed between the substrates of said pair, or impression of alternating voltage (initialization process). Also in the process in this initialization process, it is thought that each particle collides and carries out frictional electrification between particles and between a particle and a substrate surface layer. Moreover, the desired amount of frictional electrifications can be obtained according to this initialization process.

[0014] By the above-mentioned frictional electrification, at least one kind in said particle just (The just charged particle is hereafter called the 1st particle.) Other at least one kind is negative (the particle charged in negative is hereafter called the 2nd particle.). Although it is charged, respectively, and is going to adhere between particles and is going to condense with the Coulomb attraction between the 1st particle and the 2nd particle, according to the direction of the electric field impressed to the last of this initialization process, it dissociates and each particle adheres to the substrate which is one side, respectively.

[0015] Next, the 1st particle and 2nd particle adhere to separation and a substrate which moves and is different, respectively by impressing electric field according to a picture signal according to electric field. That is, it is thought that it will dissociate, and each particle will move and adhere to the substrate of the opposite side by the electric field impressed from the outside, respectively if the electrostatic force committed to each particle by which the electric charge was carried out excels rather than the Coulomb force between each particle, the image force between a particle and a substrate front face, or the force by the contact-potential difference.

[0016] It is thought that adhesion immobilization of the particle adhering to a substrate front face is carried out on a substrate front face by the image-force and Van der Waals force which are produced between substrate front faces. When the electrification nature of each particle is high, the cohesive force between particles becomes high and it is hard coming to dissociate here. The probability which the adhesion on the front face of a substrate does not move the particle with still higher electrification nature by the electric field which became high and were impressed, but fixes on a substrate front face increases. When the high floc of electrification nature is separated, there is also a possibility that discharge may arise locally and it is thought that the electrification nature of each particle becomes unstable.

[0017] On the other hand, the electrification nature of a particle is low, in the electrostatic force by external electric field, without hardly dissociating, each particle maintains the condition of having condensed loosely and the display of it is impossible, when there is almost no difference of electrification nature between the 1st particle and the 2nd particle. In order for a different polar particle to dissociate from having explained above by external electric field, it turns out that it is important that have the amount of electrifications with each suitable particle, and a reversed-polarity electrification nature particle has the frictional electrification property of being few.

[0018] Next, when the polarity of electric field is changed and a particle is moved repeatedly, by friction between each particle, or friction between a particle and a substrate front face, the electrification nature of a particle increases, the condensation between particles may occur or the phenomenon a particle fixes to a substrate surface layer and it becomes impossible to separate may be seen. At this time, the amount of electrifications of the particle group which produced image unevenness is broadcloth from the high value to the low value. Therefore, in order to maintain early operating state, change of the electrification property of a particle is considered that a small thing is important.

[0019] Although there is the approach of making an inorganic oxide particle and particles, such as a resin particle, exist in a particle front face, and controlling as the technique of carrying out electrification

control the collision with the 1st particle and the 2nd particle -- rubbing -- problems, such as a fall of the amount of electrifications by the shift to the other party particle (the 1st particle or 2nd particle) of said particle and/or the shift to a transparent electrode substrate and a fall of the display contrast by change of a fine-particles fluidity, are caused. It is important for maintenance of the electrification nature of the 1st particle and the 2nd particle, and fluid maintenance to avoid change of the physical relationship of the front face of such the 1st particle and the 2nd particle and a particle.

[0020] In this invention, the above-mentioned trouble is solved by adjusting the value of the coefficient of variation in the particle size distribution of the both sides of the 1st particle and the 2nd particle to 15% or less. That is, it became clear that effectiveness is [considering mutually the particle size distribution of the both sides of the 1st particle and the 2nd particle as sharp distribution] in equalization of the frictional electrification distribution accompanying the improvement in a fine-particles fluidity and this, stability and the separation rate of the different charged particle in a display, and concentration contrast.

[0021] In addition, in the above-mentioned explanation, although the 1st just charged particle and the 2nd particle charged in negative used the expression on condition of being one kind at a time, respectively, even if the number of both is one, respectively and it is two or more kinds, in the case of two or more kinds, the effectiveness of this invention is demonstrated satisfactory by the same mechanism of action as the above.

[0022] The particle (hereafter, in calling it "the particle in this invention", it considers as the generic name of the particle of the both sides which may be charged to positive/negative.) in [configuration of particle in this invention] this invention consists of color material and resin at least. Moreover, you may be the configuration in which the electrification control agent may be contained if needed and color material serves as an electrification control agent. The following are mentioned as a color material used in this invention.

[0023] As a color material of a black system, the black material of the stain and pigment system of carbon black, black titanium oxide, magnetic powder, other oil black, organic, and an inorganic system is mentioned. As a color material of a white system, white pigments, such as a rutile type titanium dioxide, anatase mold titanium oxide, a zinc white, the white lead, zinc sulfide, an aluminum oxide, oxidization silicon, and a zirconium dioxide, are mentioned.

[0024] In addition, as a color material of a chromatic color, a phthalocyanine system, the Quinacridone system, azo, a condensed system, an insoluble lake pigment, and the dyes and pigments of an inorganic oxide system can be mentioned. Specifically The aniline bule, cull coil blue, chrome yellow, Ultra marine blue, E. I. du Pont de Nemours oil red, quinoline yellow, Methylene-blue chloride, a copper phthalocyanine blue, the Malachite Green OKISA rate, Lamp black, a rose bengal, C. I. pigment red 48: 1, C.I. pigment red 122, C.I. pigment red 57:1, C.I. pigment yellow 97, C.I. pigment yellow 180, C.I. pigment yellow 185, and C.I. pigment blue 15: 1 and C.I. pigment blue 15:3 grade can be illustrated as a typical thing.

[0025] As for one side of the particle which may be charged to said positive/negative in this invention, it is desirable that it is the color material of a white system as a white thing and a color material in one side of the particle which in other words may be charged to said positive/negative in this invention. By making one particle into white, the tinting strength of the particle of another side and concentration contrast can be improved. At this time, titanium oxide is desirable as a color material for making one particle into white. By using titanium oxide for color material, in the range of the wavelength of the light, obliterating power can be made high and concentration contrast can be raised further. As a color material, it is titanium oxide of a rutile mold especially preferably.

[0026] As structure of the color material which serves as an electrification control agent, things, such as a thing, a metal complex, etc. with an electron withdrawing group or an electron donative group, can be mentioned. As the example, the C.I. pigment violet 1, the C.I. pigment violet 3, the C.I. pigment black 1, and C.I. pigment violet 23 grade can be mentioned. When the specific gravity of color material is set to 1, as for the addition of color material, it is desirable to consider as the range of 1 - 60 mass % to the whole particle, and it is more desirable to consider as the range of 5 - 50 mass %.

[0027] As resin which constitutes the particle in this invention Polyolefine, polystyrene, acrylic resin, a polyacrylonitrile, Polyvinyl acetate, polyvinyl alcohol, a vinyl chloride, a polyvinyl butyral, polyvinyl system resin [of **]; -- vinyl chloride vinyl acetate copolymer; -- styrene-acrylic-acid copolymer; -- the straight silicon resin which consists of ORGANO siloxane association, and denaturation object; -- polytetrafluoroethylene -- The Pori vinyl fluoride, fluororesin; polyester like polyvinylidene fluoride, polyurethane, polycarbonate; amino resin; an epoxy resin etc. is mentioned. These may be used independently, and may mix and use two or more resin. It chooses more preferably whether it is used independently or two or more resin is mixed and used by solubility with the aqueous phase. When mixing and using two or more resin, it is desirable to use the organic solvent which dissolves soluble low resin to the aqueous phase, for example, a methylene chloride, toluene, etc. These resin may be made to construct a bridge. Furthermore, the well-known binding resin conventionally known as a major component for the toners of electrophotography can be used for said particle satisfactory. It is desirable to use the resin containing especially a bridge formation component.
[0028] To the particle in this invention, in order to control electrification nature if needed, an electrification control agent may be added. As an electrification control agent, the well-known thing used for the toner ingredient for electrophotography can be used. For example, cetyl pyridyl chloride, BONTRONP-51, BONTRON E-81 (above) P-53, BONTRON E-84, BONTRON The ORIENT chemical-industry company make, COPY CHARGEPSY VP2038 : [Quarternary ammonium salt, such as made in Clariant Japan,] A salicylic-acid system metal complex, a phenol system condensate, a tetra-phenyl system compound, a metal oxide particle, and the metal oxide particle in which surface treatment was carried out by various coupling agents can be mentioned.
[0029] In two or more kinds of particles in this invention, as just had the property in which other at least one kind may be charged in negative, in at least one of kinds [them], it is necessary to adjust. When charged by the particle of a different class colliding or being rubbed, another side is just charged by one side in negative according to the physical relationship of both electrification train, respectively. In this invention, the location of this electrification train can be appropriately adjusted, for example by choosing said electrification control agent suitably.
[0030] As said electrification control agent used for this invention, it is desirable that they are colorlessness, low tinting strength, or the color and affiliated color of the whole particle contained. the impact to the hue of the particle chosen can be reduced by using the electrification control agent of colorlessness, low tinting strength, or the color of the whole particle contained and an affiliated color (getting it blocked -- the color of the color material contained in a particle, and an affiliated color).
[0031] "Colorlessness" means not having color and means that "low tinting strength" has the small effect which it has on the color of the whole particle contained here. Moreover, "the color and affiliated color" of the whole particle which are contained Although it has a hue in itself, it is the color, the same color, or the approximated hue of the whole particle contained. In the particle which means that the effect which it has on the color of the whole particle contained as a result is small, for example, contains white pigments as a color material, a white electrification control agent etc. is contained under the category of "the color of the whole particle contained, and an affiliated color." The color of the particle in which it is contained seems anyway, for what is necessary to be just to become a desired color as a color of an electrification control agent irrespective of "colorlessness", "low tinting strength", and "the color of the whole particle contained and an affiliated color."
[0032] As magnitude of the distributed unit in the particle of said electrification control agent used for this invention, a thing 5 micrometers or less is used with volume mean particle diameter, and it is desirable that it is a thing 1 micrometer or less. Moreover, you may exist in the state of compatibility in a particle. In the particle containing the electrification control agent in this invention, it is desirable to consider as the range of 0.1 - 10 mass % to the whole particle as the electrification control agent addition concerned, and it is more desirable to consider as 0.5 to 5 mass %.
[0033] To the particle in this invention, it is desirable that a resistance regulator contains further. By using a resistance regulator, it becomes possible to carry out charge exchange between particles early, and it becomes possible to attain early stabilization of equipment. It is desirable that it is the conductive

impalpable powder which a resistance regulator means the thing of conductive impalpable powder, and produces exchange of a charge and leakage of a charge moderately especially here. By making a resistance regulator live together, it becomes possible to avoid increase of the loading dose of the particle by the inter-particle friction over a long period of time, or friction between particle-substrate front faces, and the so-called charge up.

[0034] As this resistance regulator, a volume resistivity can mention the non-subtlety powder below 1x104-ohmcm preferably below 1x106-ohmcm. Specifically, the particles (for example, titanium oxide by which the tin-oxide coat was carried out) by which the coat was carried out with the tin oxide, a zinc oxide, ferrous oxide, and various conductive oxide can be mentioned. In this invention, it is desirable as a resistance regulator that it is the thing of colorlessness, low tinting strength, or the color of the whole particle contained and an affiliated color. About the meaning of these vocabulary, it is the same as that of what the electrification control agent explained by the way. If it is the range which does not bar the color of a particle as an addition of a resistance regulator, it is desirable to specifically consider as 0.1 mass % - 10 mass % extent to the whole particle satisfactory.

[0035] It is characterized by the value of coefficient of variation [in / in the particle (particle of the both sides which may be charged to positive/negative) in this invention / the particle size distribution] being 15% or less. Here, it can ask for the coefficient of variation in particle size distribution by the following measurement.

[0036] The coefficient of variation H in particle size distribution can use the measuring instrument multi-sizer II by the Beckmann coal tar company, and it can ask by performing a particle size analysis. Coefficient of variation H is computed by the following type (1) from the grain size (A) of the volume arithmetic mean diameter (arithmetic mean diameter in volume %) obtained by the particle size analysis, and the standard deviation (B) of the grain size (A) concerned.

$H=(B/A) \times 100 \ldots (1)$

[0037] This coefficient of variation H expresses the magnitude of the distribution width of face of particle size distribution. That is, distribution width of face is so narrow that coefficient of variation H is small, and it expresses that they are sharp particle size distribution. In this invention, as the above-mentioned coefficient of variation H, it is indispensable that it is 15% or less, it is desirable that it is 10% or less, and it is more desirable that it is mono dispersion.

[0038] As a grain size of the particle of two colors (for example, chromatic color particles, such as a white particle and blue) which may be charged to said positive/negative in this invention, it is desirable in the particle diameter of both particles, and a list to make distribution almost equivalent. Since an adhesion condition like the so-called 2 component developer that a large drop radial ball child is surrounded by the granule radial ball child by making distribution almost equivalent is avoided by the particle diameter of both particles, and the list, high white concentration and chromatic color concentration are obtained. If a large and small aperture is in both particle size, since it leads to a granule radial ball child adhering to a large drop radial ball child's perimeter, and lowering the depth of shade of large drop radial ball child original, it is not desirable.

[0039] Moreover, since the contrast of a color changes also with the mixing ratios of the particle of two colors, when particle diameter is almost equivalent, it is desirable [contrast] to consider as the mixed ratio from which the number of the particle of two colors becomes an EQC or near. If the number of the particle of two colors shifts greatly, the color of a particle with many ratios will become strong. However, it is not [the case where he wants to attach contrast by the display of a color tone deep in the same color, and the display of a light color tone, and] this limitation to display by the color by which the particle of two kinds of colors is mixed and it is made.

[0040] As a particle size of the particle in this invention, although there is no ****** generally, in order to obtain a good image, about 3-30 micrometers is more desirable, and it is desirable [about 1-100 micrometers is desirable, and] especially as these distribution conditions that it is mono dispersion.

[0041] As a configuration of the particle in this invention, it is desirable that it is close to a real ball. The particle near a real ball, then the contact between particles turn into point contact mostly, and contact on a particle and the inside front face of a substrate also turns into point contact mostly, and the adhesion

force based on the Van der Waals force of between particles and a particle, and a substrate inside front face becomes small. Therefore, even if a substrate inside front face is a dielectric, it is thought that a charged particle can move smoothly by electric field in the inside of a substrate.

[0042] As the manufacture approach of the particle in this invention, wet processes, such as a suspension polymerization and an emulsion polymerization well-known as the manufacture approach of the toner for electrophotography, and a distributed polymerization, and the grinding classifying method from the former are mentioned. Although the particle obtained by the wet process is a spherical particle, as for the particle obtained by the grinding classifying method, heat-treating is desirable in order to arrange the configuration of these particles in this case, since it becomes an indeterminate form particle.

[0043] Classification actuation can adjust as an approach of arranging particle size distribution. As a classifier used for classification actuation, various vibration screens, a supersonic sieve, an air operated screen, levigation, the rotor rotating type classifier that used the principle of a centrifugal force, a pneumatic elutriation machine, etc. can be mentioned, for example. These are independent or can be adjusted to desired particle size distribution by combining more than one. Also in these, when adjusting particle size distribution to a precision, it is desirable to use levigation.

[0044] The approach the component which constitutes this particle makes it move to the aqueous phase through the film which has pore, and corns the oil phase dissolved and/or distributed as the manufacture approach of the particle in this invention is the optimal. According to the approach concerned, the particle size distribution of a particle is sharp and can manufacture a particle suitable as a display particle efficiently. That is, since it is made to move to the aqueous phase through the film which has pore and is made to corn, the particle size distribution of the particle obtained can be made sharp only by the particle size of a particle being governed by the path of the pore of said film, consequently controlling the pore of said film.

[0045] The manufacture approach concerned is explained below at a detail. The component which constitutes the particle in this invention, i.e., resin, color material, and the electrification control agent added if needed, The constituent which a monomer, an organic solvent, etc. are made to dissolve and/or distribute a resistance regulator, a polymerization initiator, etc., and serves as an oil phase is prepared. The drainage system ingredients (mixture of water, water, and a surfactant etc.) which serve as aqueous phase on the other hand are prepared, the oil phase which consists of a constituent used as said oil phase, and the aqueous phase which consists of a drainage system ingredient used as said aqueous phase are divided by the film which has pore, and the constituent of said oil phase is moved to the aqueous phase through the film which has pore. Then, in order that an oil droplet may generate according to the path of said pore, the particle which corns becomes the thing of very narrow particle size distribution. Here, the magnitude of the particle obtained can be easily adjusted by adjusting the size of the path of said pore.

[0046] The film which has the pore which can be used can be manufactured by carrying out aperture adjustment by compression of etching, laser, and various ingredient particles, shaping, heat-treatment, etc. to the thing of the quality of the material of for example, various ceramics, a metal, a giant molecule, glass, etc. It is desirable to use porous glass by this invention especially.

[0047] The porous glass as film which has said pore is glass which has the pore adjusted to the narrow range, and it has the chemical composition which used silicic acid, the way acid, and the alumina as the principal component. This glass is glass made into porosity by flushing a way acid and alkali from an acid from the glass which carried out phase splitting using the property divided into the phase which consists of a way acid which is easy to melt into an acid, or alkali, and other phases, when the glass which is called micro porous glass (MPG) and milt porous glass (SPG), and contains silicic acid, a way acid, an alumina, etc. is heat-treated at hundreds of degrees C. When performing a granulation using the porous glass which has this pore, it is desirable that a configuration considers as a tubular or tabular thing as the porous glass concerned.

[0048] Moreover, it is desirable to use particle inorganic compounds, such as macromolecule dispersants, such as a well-known anion, Nonion, a cationic surface active agent, and polyvinyl alcohol, a polyvinyl pyrrolidone, gelatin, methyl cellulose, polyacrylic acid, starch, casein, oxidation silicon, a calcium carbonate, and an aluminum oxide, into the aqueous phase, if needed, in order to stabilize the

oil droplet obtained.
[0049] As an approach of moving the constituent of said oil phase to the aqueous phase through the film which has pore, reduced pressure suction may be carried out and a constituent may be introduced into the aqueous phase, and it may press fit in the bottom of pressurization and you may introduce into the aqueous phase. In addition, when using a monomer for the constituent used as said oil phase, a polymerization reaction is carried out after producing said oil droplet. Thus, the formed particle is often washed, removes a surfactant, a macromolecule dispersant, mineral salt, etc., further, adjusts grain size if needed and is obtained by drying.
[0050] The substrate in [configuration of substrate in this invention] this invention is the thing of the pair by which opposite arrangement was carried out, and said particle is enclosed with the opening between the substrates of this pair. In order for a substrate to be a plate (conductive substrate) which has conductivity and to give the function as an image display medium in this invention, it is needed that at least one side is a transparent transparent conductive substrate among the substrates of a pair. At this time, the transparent conductive substrate concerned turns into a display substrate.
[0051] As a conductive substrate used by this invention, the substrate itself may be conductivity, an insulating support surface may be electric-conduction--ization-processed, and it does not ask whether it is a crystal or it is amorphous. As a conductive substrate which is conductivity, the substrate itself can mention semi-conductors, such as metals, such as aluminum, stainless steel, nickel, and chromium, and an alloy crystal of those, Si, GaAs, and GaP, GaN, SiC, ZnO.
[0052] As an insulating base material, a high polymer film, glass, a quartz, a ceramic, etc. can be mentioned. The above-mentioned substrate itself can perform electric conduction-ized processing of an insulating base material by forming the metal mentioned by the example of the conductive substrate which is conductivity or gold, silver, copper, etc. by vacuum deposition, the sputtering technique, the ion plating method, etc.
[0053] As a transparent conductive substrate, the conductive substrate with which the transparent electrode was formed in one side of an insulating transparence base material, or the transparence base material which has conductivity in itself is used. As a transparence base material which has conductivity in itself, transparent conductive ingredients, such as ITO, a zinc oxide, tin oxide, a lead oxide, indium oxide, and copper iodide, can be mentioned.
[0054] As an insulating transparence base material, an optical fiber, a selfoc optical plate, etc. can be used for the film of transparent organic resin, such as glass, a quartz, sapphire, MgO and LiF, the transparent inorganic material of CaF2 grade and fluororesin, polyester, a polycarbonate, polyethylene, polyethylene terephthalate, and epoxy, or a plate, and a pan again.
[0055] What formed thinly metals, such as a thing formed by approaches, such as vacuum evaporationo, ion plating, and sputtering, or aluminum, nickel, Au, in extent which becomes translucent by vacuum evaporationo or sputtering is used, using transparent conductive ingredients, such as ITO, a zinc oxide, tin oxide, a lead oxide, indium oxide, and copper iodide, as a transparent electrode prepared in one side of the above-mentioned transparence base material.
[0056] In these substrates, since the front face of the side which counters affects the electrification polarity of said particle, it is a mode also with desirable also preparing the protective layer of a suitable surface state. A protective layer can mainly be chosen as the adhesive property to a substrate, transparency and an electrification train, and a pan from a viewpoint of low surface contamination nature. As an ingredient of a concrete protective layer, polycarbonate resin, vinyl silicone resin, fluorine radical content resin, etc. can be mentioned, for example. What has the small difference of the configuration of the main monomer of the particle which uses selection of resin, and frictional electrification with a particle is chosen.
[0057] With reference to a drawing, the gestalt of operation of the image display device of this invention using the image display medium of this invention is explained to a detail below [the gestalt of operation of the image display device of this invention]. Drawing 1 is the outline block diagram of the image display device of the gestalt of this operation, and drawing 2 is an A-A sectional view in drawing 1 .
[0058] The image formation equipment concerning the gestalt of this operation is equipped with the

image display medium 10 and the electrical-potential-difference generating means 26 as shown in drawing 1 . The image display medium 10 is an image display medium of above-mentioned this invention, and consists of the display substrate 8, the blue particle 22, a white particle 24, a non-display substrate 18, and a spacer 20. The laminating of a transparent electrode 4 and the protective layer 6 is carried out one by one, the display substrate 8 is constituted by one side of the transparence base material 2, similarly, the laminating of an electrode 14 and the protective layer 16 is carried out one by one, and the non-display substrate 18 is constituted by one side of a base material 12. Moreover, the transparent electrode 4 of the display substrate 8 is connected with the electrical-potential-difference generating means 26, and the electrode 14 of the non-display substrate 18 is grounded.

[0059] Next, the detail of the image display medium 10 is explained. For example, 7059 glass substrates with the 50mmx50mmx 1.1mm transparent electrode ITO are used for a base material 12 and an electrode 14 at the transparence base material 2 which constitutes the outside of the image display medium 10 and a transparent electrode 4, and a list. In addition, the base material 12 and electrode 14 by the side of the non-display substrate 18 do not necessarily need to be transparent. With polycarbonate resin (PC-Z), a coat is carried out to the inside front face (front face of a transparent electrode 4 and an electrode 14) which touches the particle of a glass substrate by 5 micrometers in thickness, and protective layers 6 and 16 are formed in it.

[0060] A spacer 20 forms the clipping 28 of a 15mmx15mm square in the center section of the 40mmx40mmx0.3mm silicone rubber plate, and space is fabricated by that it will be formed at the time of installation. A spacer 20 consists of installing the silicone rubber plate with which this clipping 28 was formed in the front face in which the electrode 14 and protective layer 16 of the non-display substrate 18 were formed.

[0061] About 15mg of mixed particles which consist of a blue particle 22 and a white particle 24 is eliminated through a screen to the space formed of the clipping 28 of a spacer 20. Then, the display substrate 8 is stuck to a spacer 20, pressurization maintenance of between both the substrates 8 and 18 is carried out with a double clip, a spacer 20 and both the substrates 8 and 18 are stuck, and the image display medium 10 is formed so that the front face in which the transparent electrode 4 and the protective layer 6 were formed may counter with the non-display substrate 18.

[0062] If a part of white particle 24 charged in the negative polarity which suited the non-display substrate 18 side when direct-current-voltage 150V were impressed to the transparent electrode 4 of the display substrate 2 of the above-mentioned image display medium 10 with the electrical-potential-difference generating means 26 moves to the display substrate 8 side according to an operation of electric field and direct-current-voltage 500V are impressed at first, many white particles 24 will move to the display substrate 8 side, and display concentration will be saturated mostly. At this time, the blue particle 22 charged in straight polarity moves to the non-display substrate 18 side. Then, the white particle 24 which adhered to the display substrate 8 also as 0V did not move the applied voltage by the electrical-potential-difference generating means 26, and it was changeless to display concentration.

[0063] As mentioned above, although the gestalt of operation was mentioned and explained about the image display device of this invention using the image display medium of this invention, this invention is not limited to the mode of the gestalt of this operation. For example, as a color of a particle, although white and a blue thing were mentioned as the example, the combination of various colors can be adopted, and it is desirable that one side is white as it is previous statement. Moreover, the magnitude of each part material is also a mere example, and the thing of various magnitude is chosen according to the purpose of use.

[0064] in addition, the image display medium of above-mentioned this invention can also use the unit which consists of the configuration as the image display device which arranges two or more cels to a plane (or the gap between the substrates which counter -- a plane -- dividing -- a cel -- constituting), and consists them of two or more image display media as one cel. By making the number of cels into the number of requests in every direction, the image formation equipment of the big screen of desired resolution can be manufactured.

[0065]

[Example] Hereafter, an example explains this invention more concretely. In the following examples and examples of a comparison, we decided to check the effectiveness of this invention by changing the configuration of a white particle and a blue particle using the image formation medium thru/or image display device of the configuration of drawing 1 explained by the term of a [the gestalt of operation of the image display device of this invention] as stated above, and drawing 2 . At this time, it was presupposed that the magnitude of each part material, the quality of the material, etc. are the same as that of what was explained by the term of a [the gestalt of operation of the image display device of this invention] as stated above.

[0066] As it was below <production of a particle>, the white particle and the blue particle were produced, respectively.

(White particle -1)

a) Preparation and styrene monomer of dispersion liquid A: 53 weight sections and titanium oxide (TIPAQUE CR 63: Ishihara Sangyo Kaisha, Ltd. make) : 30 weight sections and electrification control agent (COPY CHARGE PSY VP2038: made in Clariant Japan) : About the mixture which consists of the 1 weight section above-mentioned presentation, the ball milling which used the zirconia ball of 10mmphi was carried out for 20 hours, and dispersion liquid A were obtained.

[0067] b) Preparation and calcium carbonate of calcium carbonate dispersion liquid B: 30 weight sections and water: About the mixture which consists of the 60 weight sections above-mentioned presentation, it pulverized with the ball mill like production of dispersion liquid A, and calcium carbonate dispersion liquid B were obtained.

[0068] c) Preparation and 2% cello gene water solution of mixed liquor C: 4.3g and calcium carbonate dispersion liquid: 8.5 g.20% brine: About the mixture which consists of the 50g above-mentioned presentation, degassing was performed for 10 minutes by the ultrasonic disperser, subsequently it stirred with the emulsifier, and mixed liquor C was obtained.

[0069] d) It carried out to production of the production particle of a particle using the emulsification distribution equipment shown in drawing 3 . the film emulsification module 31 with which this emulsification distribution equipment consists of porous glass tubing 36 (the pole diameter of 2.5 micrometers, 10mmmm [phix120], ISE CHEMICALS make), and an outer case 35, and the equipment which sends the constituent of an oil phase, and the drainage system ingredient of the aqueous phase into this film emulsification module 31 -- since -- it is constituted. That is, an oil phase is formed in the gap of the porous glass tubing 36 and an outer case 35 for the aqueous phase, respectively, and an oil phase and the aqueous phase are divided into the interior of the porous glass tubing 36 with the porous glass tubing 36 which is the film which has pore.

[0070] Dispersion-liquid A35g, divinylbenzene 1g, and polymerization initiator azobisuisobutironitoriru (azo-isobutyro-dinitrile):0.35g were measured and taken, it mixed enough, degassing was performed for 10 minutes by the ultrasonic disperser, and the constituent used as an oil phase was obtained. This constituent was taught to the oil phase container 33, and it stirred with the agitator 39. Moreover, through circulation of the porous glass tubing 36 interior of the film emulsification module 31 was carried out using the liquid-sending pump 37, teaching mixed liquor C (aqueous phase) to the distributed solvent machine 32, and stirring with an agitator 34.

[0071] The constituent held in the oil phase container 33 was pressed fit in the gap of a constant rate, the porous glass tubing 36, and an outer case 35 with the quantum liquid-sending pump 38. Then, the constituent of the oil phase which penetrated the porous glass tubing 36 moves into the mixed liquor C of the aqueous phase which circulates through the porous glass tubing 36 interior, an oil droplet is made to form, finally it is supplied in the distributed solvent machine 32, and the dispersion liquid of a particle are prepared.

[0072] Thus, nitrogen gas was enclosed, after having put the formed dispersion liquid into the bottle, making silicone ** this bottle and performing reduced pressure degassing enough. And it was made to react at 70 degrees C for 10 hours, and the particle was produced. Filtration was performed, after taking this out after cooling and making 3 mol/l hydrochloric acid of an excessive amount decompose a calcium carbonate. Then, sufficient distilled water washes several times, it is made to dry with a vacuum

dryer, a micro mold acoustic wave screen machine is used after a crack, it applies to a Micro sieve SMS-75A mold (opening: screen (12.5 micrometers and 16 micrometers)), grain size is arranged, and they are volume arithmetic mean diameter =14.0micrometer and the white particle of H= 10% of coefficient of variation. - 1 was obtained.

[0073] (Blue particle -1) It set, and the process of "preparation of a dispersion liquid A" was substituted for the following process, the subsequent process in (the white particle -1) was performed using obtained dispersion-liquid A', and the blue particle -1 of volume arithmetic mean diameter =13.7micrometer and H= 12% of coefficient of variation was produced (white particle -1).

[0074]

a) Preparation and styrene monomer of dispersion-liquid A' : 90 weight sections and blue pigment (C. I.Pigment Blue 15:3, SANYO CYANINE BLUE KRO:San-yo coloring matter incorporated company) : About the mixture which consists of the 10 weight section above-mentioned presentation, the ball milling which used the zirconia ball of 10mmphi was carried out for 20 hours, and dispersion-liquid A' was obtained.

[0075] (White particle -2) Except for having set and having replaced with the actuation which shows below grain-refining actuation (actuation of using a micro mold acoustic wave screen machine, and arranging grain size) of the culmination in the process of "production of d particle", they are volume arithmetic mean diameter =13.1micrometer and the white particle of H= 14% of coefficient of variation as well as (the white particle -1) (white particle -1). - 2 was produced.

[0076] : Grain-refining actuation opening : adding water several times applying a supersonic wave in a moisture powder system using a nylon screen (10 micrometers and 15 micrometers), the screen activity was done, it penetrated, what penetrated and remained in 10 micrometers was extracted, and 15 micrometers of grain size were arranged. The vacuum drying of this was carried out, it cracked, and the white particle -2 was produced.

[0077] Set and the process of "preparation of a dispersion liquid A" is substituted for the process of "preparation of a dispersion-liquid A'" in (the blue particle -1). (Blue particle -2) (white particle -1) The subsequent process in (the white particle -1) is performed using obtained dispersion-liquid A'. Furthermore, grain-refining actuation of the culmination in the process of "production of d particle" (a micro mold acoustic wave screen machine is used) having substituted actuation of arranging grain size for ":grain-refining actuation" in (the blue particle -2) -- removing -- (the white particle -1) -- the same -- carrying out -- volume arithmetic mean diameter =12.8micrometer and H= 14.2% of coefficient of variation -- blue -- particle-2 were produced.

[0078]

(White particle -3)

a) Preparation and styrene monomer of dispersion liquid D: 53 weight sections and titanium oxide (TIPAQUE CR 63: Ishihara Sangyo Kaisha, Ltd. make) : 45 weight sections and electrification control agent (COPY CHARGE PSY VP2038: made in Clariant Japan) : About the mixture which consists of the 2 weight sections above-mentioned presentation, the ball milling which used the zirconia ball of 10mmphi was carried out for 20 hours, and dispersion liquid D were obtained.

[0079] b) Preparation and calcium carbonate of calcium carbonate dispersion liquid E: 40 weight sections and water: About the mixture which consists of the 60 weight sections above-mentioned presentation, it pulverized with the ball mill like production of dispersion liquid D, and calcium carbonate dispersion liquid E were obtained.

[0080] c) Preparation and 2% cello gene water solution of mixed liquor F: 4.3g and calcium carbonate dispersion liquid E: 8.5 g.20% brine: About the mixture which consists of the 50g above-mentioned presentation, degassing was performed for 10 minutes by the ultrasonic disperser, subsequently it stirred with the emulsifier, and mixed liquor C was obtained.

[0081] d) Production dispersion-liquid D35g of a particle, divinylbenzene 1g, and polymerization initiator azobisuisobutironitoriru(azo-isobutyro-dinitrile):0.35g were measured and taken, it mixed enough, and degassing was performed for 10 minutes by the ultrasonic disperser. This was put in into said mixed liquor C, and it emulsified with the emulsifier. Next, nitrogen gas was enclosed, after having

put this emulsified liquid into the bottle, making silicone ** this bottle and performing reduced pressure degassing enough. And it was made to react at 70 degrees C for 10 hours, and the particle was produced. Filtration was performed, after taking this out after cooling and making 3 mol/l hydrochloric acid of an excessive amount decompose a calcium carbonate. Then, they are volume arithmetic mean diameter =13.8micrometer and the white particle of H= 17.2% of coefficient of variation by sufficient distilled water washing several times, making it dry with a vacuum dryer, and classifying a desiccation particle after a crack with a wind-force type classifier (elbow jet: product made from day ironworker business). - 3 was produced.

[0082] (White particle -4) They are volume arithmetic mean diameter =14.5micrometer and the white particle of H= 20% of coefficient of variation as well as (the white particle -3) except having set and having changed the classification conditions by the wind-force type classifier in the process of "production of d particle" (white particle -3). - 4 was produced.

[0083] (Blue particle -3) It set, and the process of "preparation of a dispersion liquid D" was substituted for the following process, the subsequent process in (the white particle -3) was performed using obtained dispersion-liquid D', and the blue particle -3 of volume arithmetic mean diameter =13.4micrometer and H= 17.5% of coefficient of variation was produced (white particle -3).

[0084]

a) Preparation and styrene monomer of dispersion-liquid D' : 90 weight sections and blue pigment (C. I.Pigment Blue 15:3, SANYO CYANINE BLUE KRO:San-yo coloring matter incorporated company) : About the mixture which consists of the 10 weight section above-mentioned presentation, the ball milling which used the zirconia ball of 10mmphi was carried out for 20 hours, and dispersion-liquid D' was obtained.

[0085] Set and the process of "preparation of a dispersion liquid D" is substituted for the process of "preparation of a dispersion-liquid D'" in (the blue particle -3). (Blue particle -4) (white particle -3) Using obtained dispersion-liquid D', perform the subsequent process in (the white particle -3), and further except having changed the classification conditions by the wind-force type classifier in the process of "production of d particle" The blue particle -4 of volume arithmetic mean diameter =14.2micrometer and H= 18.5% of coefficient of variation as well as (the white particle -3) was produced.

[0086] It used in the combination which shows each particle obtained the account of a <preparation of mixed particle> top in the following table 1, this was mixed, and the mixed particle used in an example and the example of a comparison was prepared. this time -- as the rate of a compounding ratio of a white particle and a blue particle (number criteria) -- white particle: -- blue -- it was made to be set to particle =2:1

[0087]

[Table 1]

表 1

	白色粒子	青色粒子
実施例 1	白色粒子－1	青色粒子－1
実施例 2	白色粒子－2	青色粒子－2
比較例 1	白色粒子－3	青色粒子－3
比較例 2	白色粒子－4	青色粒子－4

[0088] Each mixed particle <production of an image-display medium> Obtained was enclosed with the opening between the substrates (the display substrate 8, non-display substrate 18) by which opposite arrangement was carried out. Impressing an electrical potential difference (500V) between the transparent electrode 4-electrodes 14 of the obtained image formation equipment, each particle 22 and 24 moves between the display substrate 8-non-display substrates 18 by making desired electric field act on the particle group between the display substrate 8-non-display substrates 18. By changing the polarity of the electrical potential difference to impress, each particles 22 and 24 move in the different direction between the display substrate 8-non-display substrates 18, and go back and forth between the display

substrate 8-non-display substrates 18 by repeating and changing an electrical-potential-difference polarity. In this process, it is charged in a polarity different, respectively in a particle 22 and a particle 24 by the collision between each particle 22 and 24 and between particles 22 and 24, the display substrate 8, or the non-display substrate 18.

[0089] the uniform high concentration which the white particle -1 is charged in straight polarity, the blue particle -1 is charged in negative polarity, each particles 22 and 24 will adhere to the display substrate 8 or the non-display substrate 18 in this example, respectively if it moves in the mutually different direction according to the electric field between the display substrate 8-non-display substrates 18 and electric field are fixed to an one direction, and does not have image unevenness -- high -- a contrast image is displayed.

[0090] In the image formation equipment using each mixed particle of a <evaluation trial> example or the example of a comparison, the polar change of the above-mentioned electrical potential difference was performed for every second, and each particles 22 and 24 were moved in the direction where it differs between the display substrate 8-non-display substrates 18 for every second. It is 1600 cycle ********** about this change. Then, the polar change of an electrical potential difference was made into every 0.1 seconds. And cycle evaluation was repeatedly performed until it was remarkable at intervals of the polar change concerned and the fall of reflection density was seen, the count of a cycle until it will be in the condition that the fall of this reflection density does not bear use was evaluated, and this was made into the evaluation index of endurance. Moreover, the following indexes estimated the comprehensive stability in this case. A result is shown in the following table 2.

(Index of comprehensive stability evaluation)

O : on the whole, the fall of the contrast of an image accompanying a repeat cycle is uniform, and the display without nonuniformity is stable.

x: The fall of the contrast of an image accompanying a repeat cycle occurs at the edge of an unit cell plate, much partial contrast falls occur, it becomes nonuniformity uneven on the whole, and a clear display becomes impossible.

[0091]

[Table 2]

表2

	耐久性 (×1000サイクル)	総合安定性評価
実施例1	150	○
実施例2	120	○
比較例1	30	×
比較例2	15	×

[0092]

[Effect of the Invention] As explained above, even if it repeats and rewrites a display image over a long period of time according to this invention, a small and homogeneous change of display image concentration also has a small change of display image concentration, and it can offer the image display medium by which concentration contrast was stabilized, and the image formation equipment using it.

[Translation done.]